SECTION 1: INTRODUCTION

Wastewater collection and treatment systems are major capital investments in the infrastructure of municipalities across the nation. The proper performance of these systems is vital to enabling citizens and those conducting business in the municipalities to go about their daily lives. These systems do malfunction. When that happens, it can pose significant risks to public health and the environment, and thus adversely impact the overall quality of life. A major form of system malfunction is sanitary sewer overflows (SSOs). A SSO is defined as the discharge of untreated or partially treated wastewater from a separate sanitary sewer system.

The US Environmental Protection Agency (EPA) is in the process of developing a national policy addressing National Pollutant Discharge Elimination System (NPDES) requirements for sanitary sewer collection systems and SSOs. The need for a national policy has prompted the need to increase the level of our understanding of SSOs; their causes, their effects, and their relationships with other observable measurements such as weather, population change, level of maintenance activities, etc.

Recent discussions by experts pointed out that it is probably most beneficial to consider SSOs in several different types. For example, in the draft of Sanitary Sewer Overflow and Sanitary Sewer Operation, Maintenance, and Management Unified Paper, Avoidable SSOs and Unavoidable SSOs were defined. Others talked about wet weather and dry weather SSOs. Although not completely equivalent, both definitions are largely similar in the sense that dry weather SSOs are likely avoidable under sufficient maintenance activities, and an intense storm might overwhelm a sewer system regardless the level of maintenance activities.

Let us consider the following assumption:

If:

1. a sewer system had unlimited capacity (unlimited sewer pipe size, unlimited treatment capacity, and unlimited backup capacity), and
2. the system was maintained with unlimited manpower and financial resources,

then there would have been no SSOs.

If we accept this (reasonable) assumption, then it is clear that every SSO can be attributed to a lack of either system capacity, or system maintenance, or both. For the ease of writing in this report, let us refer to the two components as Capacity related and Maintenance related, respectively.

The Capacity related SSO problems are traditionally studied by engineers via simulation models. For example, the Sanitary Sewer Overflow Cost/Benefit Analysis recently conducted by Eastern Research Group, Inc, and Metcalf & Eddy, for the US EPA depended heavily on a computer simulation model. Generally, it is believed that the computer models capture well the state of a sewer system, in the Capacity related dimension.

There is an orthogonal dimension to the system capacity in SSO problems; i.e., and the maintenance activities. Although it is well understood that a sewer system maintenance program is very important, few have been able to quantify its impact on the system performance. Some even had difficulty in establishing any usefulness of maintenance programs in their analysis (Stalnaker and Rigsby 1997). Such difficulties seem to have been caused by, among other things, the severe lack of quality and sizable data on SSOs by municipalities.

As an exception, the CMU has kept good SSO records for approximately 15 years. They have also kept daily work records by maintenance crews for at least as many years. This database provided an opportunity to explore the relationship between sewer performance and maintenance types and maintenance intensity. The main objective of this study is to attempt to establish and to quantify such a relationship.

As we model the SSOs in the database provided by CMU, the first question to be clarified is how to characterize these types of SSOs.

We considered the definition of Avoidable SSOs, but thought it inadequate. An avoidable SSO should be one that can be avoided by some form of human activities. As evidenced by the study results (appearing later in this report), the SSOs recorded in the CMU data were not completely so.

We also considered the definition of Dry-weather SSOs, but thought it inadequate still. After all, many of the SSOs in CMU database were triggered by some rain but not overwhelming storms. The original definition of Dry-weather SSOs may have been prompted by the fact that SSOs were experienced more frequently in the winters, usually the drier seasons. In the Piedmont region of North Carolina, the winter weathers are quite wet, and SSO frequency is still higher in the winters.

The term of Maintenance-Related SSOs is very close to Avoidable SSOs, can not be used to describe the SSOs in question for the same reason why Avoidable SSOs was inadequate.

Overall, it is appropriate to define two types of SSOs, for the purpose of this study, as follows.

- **Type *A* SSO** -- Type *A* SSO is an SSO that occurs because of the lack of capacity at the treatment plants - its wastewater treatment capacity, its back-up capacity, etc. Type *A* SSOs usually occurs at or very near a treatment plant.
- **Type *B* SSO** -- Type *B* SSO is an SSO that is not a type *A* SSO.

With the above definitions, we can comfortably claim that the model to be developed in this study is for the frequency of the type *B* SSOs.